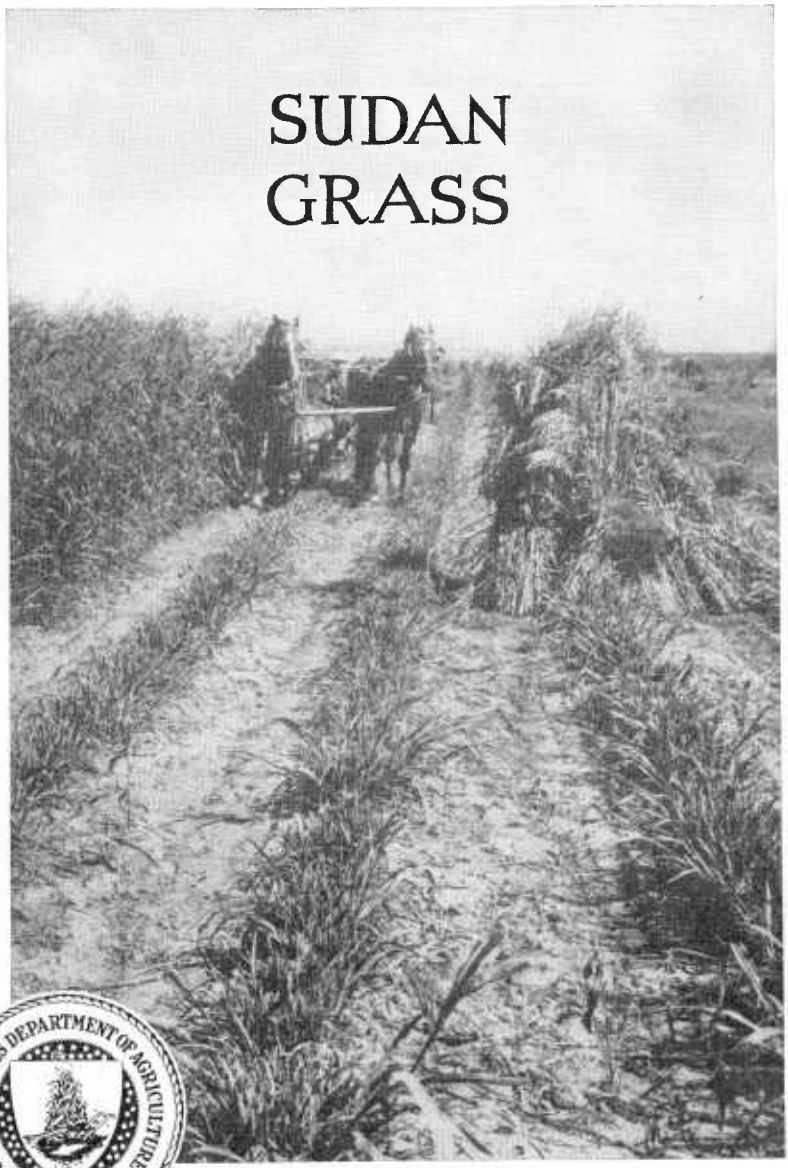
U. S. DEPARTMENT OF AGRICULTURE
FARMERS' BULLETIN No. 1126

SUDAN GRASS



SUDAN GRASS is grown for hay and summer pasture. It was obtained in 1909 from the Sudan Government at Khartum as the result of a systematic search for a form of Johnson grass without rootstocks. No other plant importation ever gained such immediate and widespread popularity in the United States.

Sudan grass is strictly an annual, without underground rootstocks. It grows to a height of 3 to 5 feet in drilled seedings and 5 to 8 feet in cultivated rows. Drilled seedings are generally preferred for hay and the cultivated rows for seed production.

Sudan grass requires a warm climate for its best development and is of most value as an emergency hay crop, being superior to millet for this purpose in all except the northern third of the United States.

In irrigated sections of the Southwest, Sudan grass yields practically as much hay as alfalfa and is very useful in providing a variety of roughage for dairy cows.

The best time to cut Sudan grass for hay is when it is in full head, but the grass can be harvested somewhat earlier or later than this with no material loss in feeding value.

Sudan grass is a good soiling crop, but is of minor value for silage. The hay is equal in feeding value to that of timothy, millet, or Johnson grass.

It is being utilized more and more as a summer pasture in the Central and Southern States and is valuable as a pasture in the irrigated districts of the Southwest.

There is less danger of prussic-acid poisoning in pasturing or feeding Sudan grass than with larger sorghums, but care must be observed in pasturing the grass, especially in the Northwestern States.

Feeding experiments have shown Sudan grass hay to be an excellent roughage for work animals and stock cattle and only slightly less valuable than alfalfa hay for milk cows.

Seed production is profitable only in certain favored localities. Johnson grass seed is dangerous as an adulterant in Sudan grass seed south of the thirty-eighth degree of latitude only. There Johnson grass behaves as a perennial and is difficult to eradicate.

Sudan grass hybridizes freely with the sorghums, and care is necessary to keep it from becoming a mongrel crop, as have many of the sorgos.

Washington, D. C.

Issued May 1920; revised November 1931
Slightly revised April 1940
Slightly revised August 1941

SUDAN GRASS.

By H. N. VINALL, *agronomist, Division of Forage Crops and Diseases, Bureau of Plant Industry.*

CONTENTS.

ORIGIN OF SUDAN GRASS.

SUDAN GRASS was discovered and introduced into the United States during a systematic search for forms of Andropogons lacking the aggressive rootstocks which sometimes convert Johnson grass into an obnoxious weed and without which it would be a much more valuable hay plant for the Southern States. C. V. Piper, Agrostologist in Charge of the Office of Forage-Crop Investigations, directed this search. With the assistance of the Office of Foreign Seed and Plant Introduction, 8 ounces of seed of a grass known as garawi was obtained on March 15, 1909, from R. Hewison, Director of Agriculture and Lands of the Sudan Government at Khartum.[1] A portion of this seed, planted that spring at the Forage-Crop Field Station, Chillicothe, Tex.[2] proved very promising. The grass has since been grown at many other points. It was given the distinctive name "Sudan grass."

DESCRIPTION OF SUDAN GRASS.

Under cultivation in the United States, Sudan grass has shown itself to be distinctly an annual. Only under practically frost-free

[1] Piper, C. V. Sudan grass, a new drought-resistant hay plant. U. S. Dept. Agr., Bur. Plant Indus. Cir. 125, 20 p., 6 figs. 1913. Out of print; may be consulted in libraries.
Oakley, R. A. Some new grasses for the South. *In* Yearbook, U. S. Dept. Agr., for 1912, p. 495–504, 6 pl.
Vinall, H. N., and R. E. Getty. Sudan grass and related plants. U. S. Dept. Agr. Bul. 981. 68 p., 25 fig. 1921. (This bulletin contains a detailed account of the introduction of Sudan grass and several other species of grass sorghums, as well as a summary of the results of numerous experiments with Sudan grass in the United States.) Out of print.

[2] The field station at Chillicothe, Tex., is maintained as a cooperative project in conjunction with the Texas Agricultural Experiment Station. From its inception, in 1905, up to 1916 the expenses were borne largely by the United States Department of Agriculture. In 1915, 100 acres of land 5 miles southwest of Chillicothe were purchased by the State of Texas and designated "Texas Substation No. 12." The cooperation between the Office of Forage-Crop Investigations of the United States Department of Agriculture and the Texas Agricultural Experiment Station has been continued at the new location. The administration of the station since January 1, 1916, has been in the hands of the Texas station, and the State of Texas has made liberal financial contributions to support the work. An account of the trials of Sudan grass at the State substations throughout Texas is given in Texas Agr. Exp. Sta. Bul. 172.

conditions, such as obtain along the Gulf coast and in southern California, have plants lived over winter. This grass is very closely related to the cultivated sorghums and hybridizes with them readily. The fact that it has no rootstocks places it nearer the cultivated sorghums than Johnson grass, though for many years Johnson grass

FIG. 1.—Single plant of Sudan grass, illustrating its habits of growth when planted in rows.

has been credited by some botanists with being the primitive form of the sorghums.

Sudan grass when seeded broadcast or in drills grows about 3 to 5 feet high and has stems about three-sixteenths of an inch in diameter (a little smaller than a lead pencil). If grown in rows and cultivated, it reaches a height of 6 to 8 feet, and the stems are about one-

fourth of an inch in diameter (fig. 1). The panicle is loose and open, very much like that of Johnson grass, but a little larger and a trifle less open. The hulls, or glumes, are awned and when in flower

FIG. 2.—Young plants of Sudan grass (left) and Johnson grass (right), showing the vigorous rootstocks of Johnson grass and their entire absence on Sudan grass.

are often purplish in color. The grain usually fades to a pale yellow when ripe. The awns are broken off in threshing, so that the commercial seeds rarely have awns. The leaves are broader and more

numerous than those of Johnson grass, giving the grass a much more favorable appearance as a hay plant. The most important difference, however, is that the aggressive underground stems, or rootstocks, with which Johnson grass is equipped, are entirely absent in Sudan grass. This striking difference is shown clearly in the accompanying figure illustrating young seedling plants of the two grasses (fig. 2). Sudan grass, like the cultivated sorghums, never develops anything but fibrous roots, therefore it can not become an obnoxious weed as the perennial Johnson grass does. Furthermore, it has shown no tendency to persist in fields as an annual weed through volunteer seedings. When it has plenty of room the grass tillers very freely. It is not uncommon to find over 100 stems arising from one crown. This decided tendency to tiller is most apparent after the first cutting, and usually makes the hay from the second cutting of finer texture than that from the first.

CLIMATIC REQUIREMENTS.

Sudan grass, like sorghums, does best in a warm climate. In favorable seasons, where the growing period is long, as many as four cuttings can be obtained in one year. As in the case of all other crops, in determining the regions of greatest importance, climatic and soil conditions are linked with the acuteness of the need for such a crop. The principal regions of production in the United States are shown on the map (fig. 3), as follows:

Region 1.—Two or three good cuttings of hay are secured without irrigation in this region, the yields varying from 2 to 4 tons to the acre. This is the region of its greatest importance because of the need for a better hay grass in these States. Profitable seed yields are secured west of the ninety-eighth meridian only, the sorghum midge usually preventing seed formation in the more humid district east of this meridian.

Region 2.—Sudan grass thrives here almost as well as in region 1, making good yields both of hay and of seed. Timothy, clover, and alfalfa, however, meet the hay requirements of this region so fully that Sudan grass is valued chiefly as a pasture and catch crop or for limited culture on soils not suited to these forage crops.

Region 3.—This comprises the region west of region 2, where the rainfall is too low for the successful cultivation of timothy and clover. Sudan grass commonly makes one cutting under such conditions, and in favorable seasons two, yielding 1 to 3 tons of hay to the acre. Its chief competitors in this region are alfalfa, sorghum, and millet. Alfalfa is preferred to Sudan grass only in the more favored locations, such as river and creek valleys or where irrigation is possible. The better varieties of sorghum, such as Red Amber and Orange, will outyield Sudan grass, but the latter is better suited for pasture purposes, produces a better quality of hay, and is easier to handle with haying machinery. Seed production, though possible in most of this region, is profitable only in the southern part.

Region 4.—Sudan grass yields abundantly both in hay and in seed in all irrigated localities in this region; yields of 4 tons of hay to the acre are not uncommon on good soils. It is used chiefly to supplement alfalfa in the rations of horses and dairy cattle.

Region 5.—In this part of the United States Sudan grass is successful only in limited areas. Its failure except in these localities is due either to low temperatures caused by high altitudes or to insufficient rainfall.

Region 6.—In this region, including Florida and the Coastal Plain along both the Atlantic and Gulf coasts, Sudan grass is usually a failure, largely on account of the injury to the foliage caused by diseases.

Region 7.—This is a region 100 to 200 miles wide along the northern border of the United States. Sudan grass is not grown extensively in this section because of the cool summers and short growing season.

Since its introduction in 1909 Sudan grass has become known in nearly every part of the United States and is now being grown where it was at first thought to be wholly unadapted. Its short growing period permits it to thrive and make good crops of hay as far north as southern Michigan and New York. Throughout the timothy and clover region, though it may never become the leading hay grass, it will be used more and more as a catch crop in place of the millets and for summer pasture. In the Rocky Mountain region (fig. 3, region 5) the results are for the most part unfavorable except in the irrigated valleys. At the higher altitudes untimely frosts and continued low temperatures during the summer months preclude a successful growth. The upper limits of profitable hay production seem to be 6,000 to 8,000 feet in New Mexico, Arizona, and southern California; 5,000 to 6,000 feet in Colorado, Utah, Nevada, and northern California; and 4,000 to 5,000 feet north of those States.

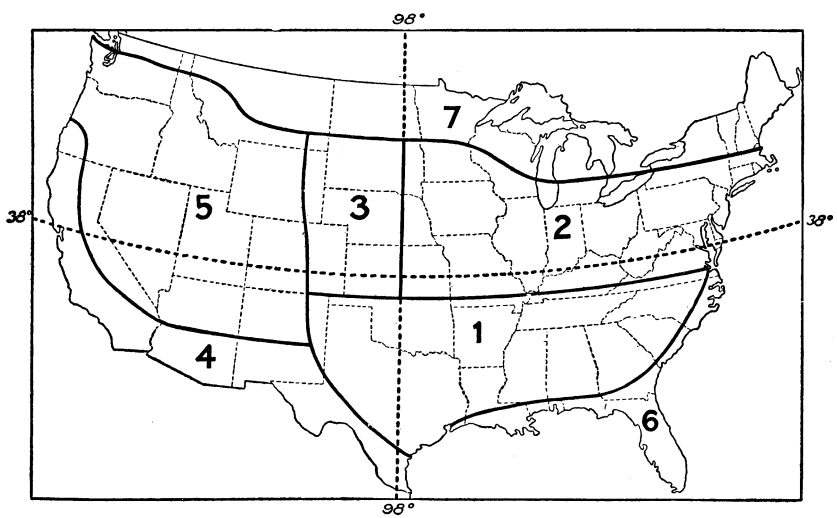


FIG. 3.—Outline map showing the forage value of Sudan grass in different parts of the United States.

The altitudinal limits for seed production are at least 1,000 feet lower, respectively, than those named for hay, because under cool conditions it takes a month or more to mature seed after the crop is ready to be cut for hay.

DROUGHT RELATIONS.

That Sudan grass will grow and produce fair crops in regions of low rainfall has been demonstrated by numerous tests in the Great Plains. Its ability to endure periods of drought is equal, though not superior, to that of the best varieties of sorghum. In the South, where drought is usually combined with extreme heat, Sudan grass yields much better than millet, but in Montana and the Dakotas millet makes a slightly larger yield.

Experiments have shown that Sudan grass requires a greater amount of water to produce a pound of dry matter than does corn,

sorghum, or millet. Notwithstanding this indicated high water requirement, Sudan grass has been successfully grown as a dry-land crop since 1912, when the first wide distribution of seed took place. As an emergency hay crop and summer pasture no other crop is better suited to conditions in the southern half of the Great Plains.

On the university farm at Davis, Calif., it has been grown with good results as a dry-land crop and is recommended for use in other parts of that State where irrigation water is not available.[3]

SOIL REQUIREMENTS.

Sudan grass is not at all exacting in its soil requirements. It does best on a rich loam, but it has been grown successfully on almost every class of soil from a heavy clay to a light sand. Where the soil is quite sandy, however, the yield may be expected to be light. Cold, wet, muggy soils are particularly unsuited to Sudan grass. Before such soils will grow it, thorough drainage must be provided. Small amounts of alkali in the soil reduce the yields markedly and stronger concentrations prevent profitable culture.

PLACE IN THE CROPPING SYSTEM.

Although Sudan grass is an annual and can be introduced easily into any rotation, it probably never will be widely used as a staple crop in permanent rotations. To fill such a position acceptably a crop must serve either a "money crop" or as a soil improver. Under certain conditions in the Southern States Sudan grass utilized as a hay crop or for seed production may be considered as a cash crop, but in most cases it will be grown as an emergency hay crop or for summer pasture.

The other two crops most widely grown as catch crops or emergency hay crops are millet and sorgo, or "cane" (fig. 4). The yields of Sudan grass, as compared with these two, its chief competitors, over a series of years from 1912 to 1919 and at a considerable number of stations are given in Table 1.

TABLE 1.—*Comparison of Sudan grass with millet and sorgo in yields per acre of cured hay.*

Region.	Yield per acre (tons).		
	Sudan grass.	Millet.	Sorgo.
Northern Great Plains	1.49	1.89	2.24
Central Great Plains	1.78	1.51	2.89
Southern Great Plains	3.33	1.83	4.64
Timothy and clover belt	2.80	2.52	6.06

It will be seen that in the northern Great Plains Sudan grass is less productive than millet. In the central Great Plains and the timothy and clover belt Sudan grass shows an average hay yield of about one-fourth ton per acre greater than the yield of millet, while

[3] Madson, B. A., and P. B. Kennedy. Calif. Agr. Exp. Sta. Bul. 277, p. 200. 1917.

in the southern Great Plains its yield is nearly twice that of millet. The yield of sorgo in drilled or broadcast seedings averages in each region, except the timothy and clover belt, about 1 ton more hay per acre than Sudan grass. This is partly because of the larger amount of moisture in the sorgo hay, due in a measure to the greater difficulty of curing its coarse stems. Any difference in the actual yield of dry matter is offset in some degree by the better quality of the Sudan grass hay.

VALUE IN IRRIGATED REGIONS.

In many of the irrigated parts of the West where alfalfa is the principal crop and dairying the chief industry of the people, alfalfa has been made the constant and the almost complete diet of the cows.

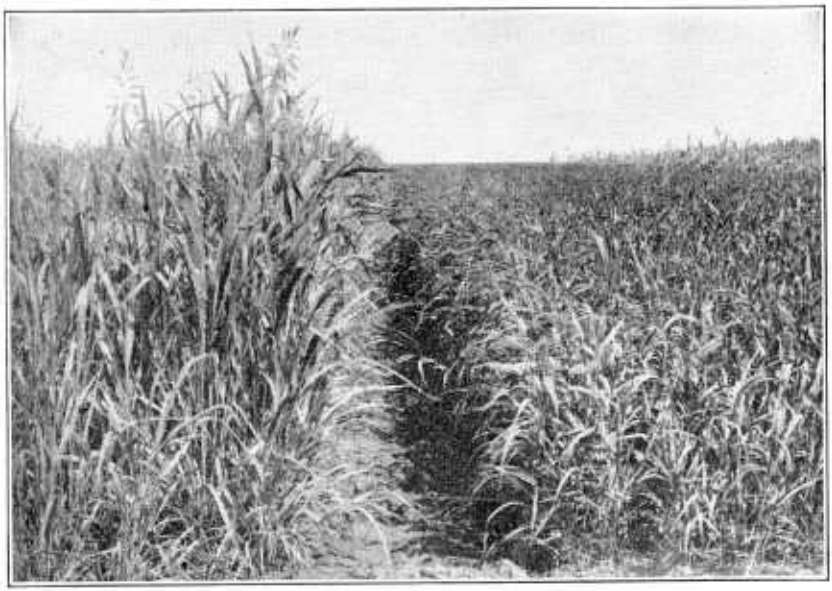


FIG. 4.—A plat of Sudan grass (at left) grown beside a plat of Kursk millet at Redfield, S. Dak. Both crops are in approximately the right stage to be cut for hay.

The continuous use of this high-protein hay has caused digestive troubles, but this derangement of the digestive functions seems to disappear promptly when the feed is changed. Under irrigation south of Oregon and Wyoming Sudan grass makes an excellent crop to grow for mixing with alfalfa. Yields of cured hay obtained under irrigation in California and Arizona have been equal and in some cases larger than those from alfalfa. At Chico, Calif., Sudan grass when irrigated gave a yield of 9.8 tons of cured hay per acre, as compared with a yield of 8.3 tons of alfalfa hay; and at Bard, Calif., in the extreme southern end of the State, Sudan grass on favorable soil gave a yield of 8 tons of hay per acre, as compared with 7.9 tons of alfalfa. The yield of 8 tons at this place was obtained from grass planted almost a month later than it should have been. At Phoenix,

Ariz., the yield of Sudan grass was 7.8 tons per acre, as compared with a yield of 9.8 tons of alfalfa, and at Owens, Ariz., Sudan grass made a yield of 4.5 tons per acre with only one irrigation during the season.

These unusual yields of hay from an annual crop, which by its nature can be made to fit into any rotation, will no doubt mean much to the dairying industry of the Southwest.

The percentage of moisture is apt to be somewhat greater in Sudan grass than in alfalfa when the weights are taken directly from the field, but less labor is necessary to handle the Sudan grass because the maximum yield from it is secured in three cuttings, while with the alfalfa five or more cuttings are required to produce the yields mentioned.

Sudan is the only grass which yields under irrigation in the Southwest even approximately as much as alfalfa. It can be used, therefore, in providing a change of feed without reducing the tonnage obtained from the land. Sudan grass was found just in time to fill this need, and although it is not as rich in protein as alfalfa, experience indicates that when mixed with alfalfa or fed with some concentrate rich in protein the flow of milk will be nearly or quite normal.

SUDAN GRASS AND LEGUME MIXTURES.

The suitability of Sudan grass for growing in mixtures with cowpeas, soy beans, and other legumes in regions to which Sudan grass and these legumes are well adapted is at once apparent. (1) Sudan grass grows strictly erect, with a stem stiff enough to support the vines characteristic of most legumes, and it thus makes the harvesting easier by keeping the legumes off the ground. It also allows them to cure more quickly by preventing the leaves from matting. (2) It is low in protein, which is abundant in the legumes, and thus a well-balanced mixture is produced. (3) The yields in the humid regions are equal to those of Sudan grass when seeded alone, but the difficulty of getting a good stand and of harvesting the mixture is greater.

Tests of Sudan grass and legume mixtures in the States of Maryland, Virginia (fig. 5), Kentucky, Tennessee, Mississippi, and Louisiana during a 4-year period gave the following average yields: For Sudan grass and soy beans 2.96 tons, Sudan grass and cowpeas 2.93 tons, and Sudan grass alone 2.67 tons per acre. In dry regions such mixtures are not profitable except when irrigated. If there is insufficient soil moisture to support both the Sudan grass and the legume, the grass almost invariably crowds out the legume. The growing of such mixtures should therefore be attempted only in humid regions or where irrigation is possible.

CULTURE.

PREPARATION OF THE SEED BED.

In seeding Sudan grass a rather firm seed bed is best. Usually when it is desired to drill the seed, the ground is plowed in the spring and harrowed well, as for corn. A cool soil delays the germination of the seed; therefore spring plowing is preferable for the seed bed,

because it assists in warming the soil. No fertilizers are necessary in the West, where the soil is reasonably good, but in the East it is probably advisable to use some complete fertilizer, such as is applied for corn, or some combination of phosphorus and nitrogen, if the price of potash is high. Few experiments have been conducted to determine the best practice to follow, but in Kentucky applications of superphosphate at the rate of 200 pounds per acre resulted in increases of yield in 8 out of 10 cases. The average increase attributed to the fertilizer was 68 per cent.

DATE OF SEEDING.

It has been found best to seed Sudan grass after the soil has become warm, or about two weeks after corn-planting time. When

FIG. 5.—Plats at Arlington Experiment Farm, Va., showing mixtures of Sudan grass and cowpeas (right) and Johnson grass and cowpeas (left).

sown in cold soil the result usually is a poor stand or a slow growth for several months, so that in the end no advantage has accrued from the early seeding.

Widely scattered experiments have shown that in very few cases are the earliest seedings highest in hay yield. The experience so far gained by the United States Department of Agriculture in its tests indicates that for the extreme South the best time for seeding lies between April 1 and May 1; in the latitude of Oklahoma and Kansas, any time between May 1 and June 15 (fig. 6); and in the latitude of Nebraska and South Dakota between May 15 and June 15. From Kansas south good crops of hay can be secured from seedings made July 1 or even later.

METHOD OF SEEDING.

For hay production in regions of abundant rainfall the best machine for seeding is no doubt the common grain drill. Well-cleaned seed feeds freely from this drill, and it can be distributed evenly and a good stand thus secured. If a press drill is used the ground is left level and in good condition for the mower. The depth of seeding has but little effect on the root system of Sudan grass. It seems to be a characteristic of the grass that the root system begins near the surface of the soil, regardless of the depth at which the seed is placed. The best depth, everything considered, is about 1 inch, but where the soil does not become packed the plant will force itself to the surface even from a depth of 3½ to 4 inches.

In the semiarid regions for hay, and in any locality for seed production, better results are obtained by seeding in rows far enough apart to allow cultivation. This can be accomplished with a grain

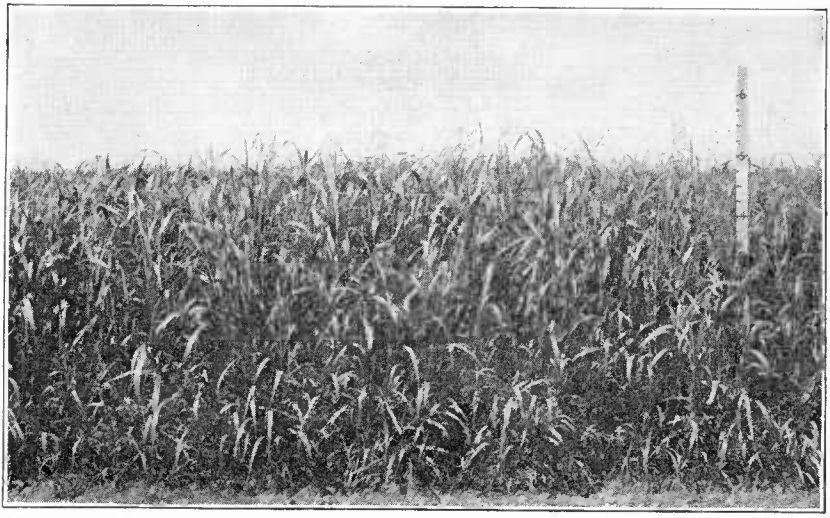


FIG. 6.—A close-up view of a field of Sudan grass seeded with a grain drill on June 1. Photographed August 12 at Hays, Kans.

drill by stopping up a sufficient number of the holes so that the rows will be the desired distance apart. If only the ordinary corn cultivators are available for the work it is best to place the rows 36 to 42 inches apart (fig. 7). If a beet cultivator or some similar tool is available, larger yields can be obtained from rows 18 to 24 inches apart. Twenty-four inches is perhaps as close as practicable, unless horses especially trained to walk between the rows are to be had. Otherwise much of the stand will be destroyed by trampling in rows less than 24 inches apart. Against any difference in favor of the cultivated-row planting over the broadcast field will have to be charged the cost of cultivation. A better quality of hay is produced from the broadcast stand, owing to the finer stems. The grass grown in cultivated rows is likely to be coarse and therefore not so desirable for market hay. For home feeding the coarseness will be of little disadvantage, as the stems do not become so woody that they are refused by stock.

RATE OF SEEDING.

Rates of 10 to 40 pounds of seed to the acre have been tested at the different agricultural experiment stations. There was, however, no definite superiority indicated for any one of these rates in drilled seedings. Sudan grass tillers so profusely in thin stands that the final number of stems per square foot of ground is usually very nearly the same, whether the rate is 15 or 40 pounds. Taking all the factors into consideration, 20 to 25 pounds per acre are recommended for drilled or broadcast seedings in the humid regions and 12 to 15 pounds in the dry sections. Under irrigation, 15 to 20 pounds of seed

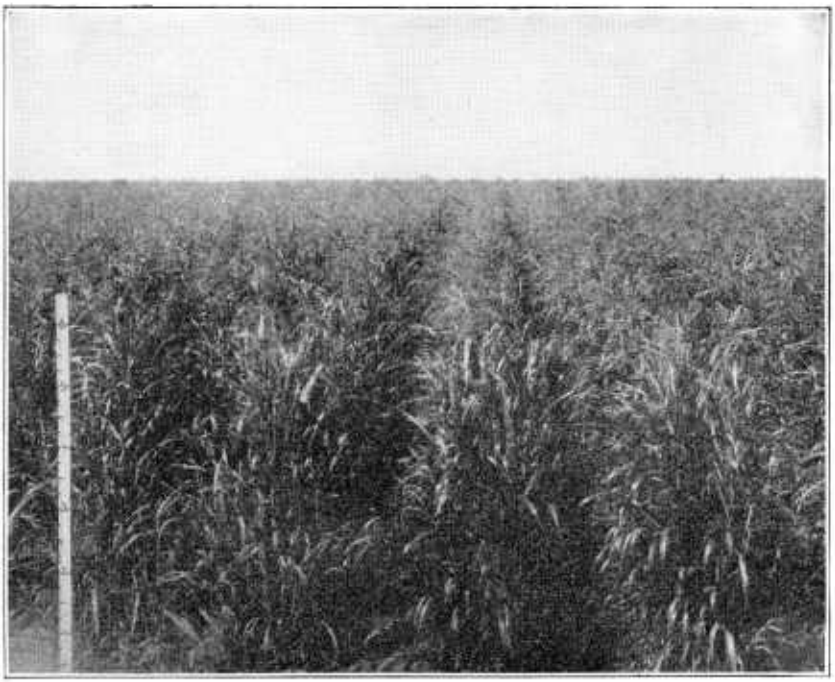


FIG. 7.—Sudan grass planted in rows 42 inches apart for seed production. Photographed at Hays, Kans., September 9.

are sufficient, owing to the more favorable conditions for germination. These quantities should be proportionately increased if the seed is of low germination or the soil in poor physical condition. A grain drill set to sow 2 pecks of wheat to the acre will ordinarily sow about 20 to 25 pounds of Sudan grass seed. If it is desired to sow a less quantity, this can be accomplished by stopping alternate holes in the drill or by mixing the Sudan grass seed with bran or some other mill feed in any proportion necessary.

For seeding in cultivated rows 36 to 44 inches apart, 2 to 4 pounds of seed per acre will be found sufficient, while in rows 18 to 24 inches apart, 4 to 6 pounds per acre will be required, the smaller quantity being used, as in the broadcast seedings, for regions of light rainfall. If the crop is intended for hay, enough seed should be used in any

case to insure a thick stand of plants in the row. When a seed crop is desired, the rate of seeding should ordinarily be somewhat less than for a hay crop.

HARVESTING.

The most common way of harvesting the grass for hay is with a mower. It cures readily and can be cut in the morning and, if the sun is bright, raked up that afternoon or the next day. After bunching, it is placed in cocks, just as with millet, and removed from these cocks to the barn or stacks after it has thoroughly cured. Because

FIG. 8.—Bundles of Sudan grass, illustrating its rapidity of growth. From left to right: No. 1, 71 days; No. 2, 56 days; No. 3, 42 days; No. 4, 28 days; and No. 5, 13 days from date of seeding. Sudan grass should not be cut for hay until it has reached the stage of maturity shown by bundles 1 and 2.

of the large amount of juice in the stems of Sudan grass, the leaves cure first and the hay often appears ready to stack when it is not; therefore, the only sure way to avoid injury by heating is to allow Sudan grass to remain in cocks long enough for the stems to become dry. The leaves are retained well, and if cut at the right stage of maturity and handled properly it will make a bright, leafy, sweet hay of the very best quality.

Where the crop is desired for seed, it is harvested like the small grains with an ordinary grain binder and allowed to cure in shocks.

This method can also be used in making hay in the semiarid regions where such good drying weather prevails that the grass will cure in the shock. Where the planting is made in cultivated rows, a corn or row binder can be used, but in most cases a grain binder is preferable. Sometimes, where the growth is rank, trouble is experienced in getting the reel over the tops of the plants and at the same time cutting a short stubble.

The time for cutting is governed to some extent by the fact that several cuttings are expected in most cases, and this often makes it seem more profitable to cut the first time as early as possible, so that the grass will have more time for the second growth (fig. 8). Experiments have shown, however, that early cutting is not justifiable either from the standpoint of total yield or from that of food value. At the Fort Hays experiment station, Hays, Kans., the average seasonal yield of air-dry hay for five years was as follows:

	Tons per acre.
1. Cut just before heading	1.86
2. Cut as the first heads appeared	2.23
3. Cut when in full head	2.15
4. Cut when the seed was in milk	2.28

In the first stage two cuttings were obtained each year; in the second stage in three out of four years; and in the third stage in only two of the years. In the fourth stage only one cutting a year was obtained, but the average yield was the largest of the four methods.

The above experiment clearly shows that it is not profitable to cut Sudan grass before it has begun to head. The preferable stage of maturity for cutting is from the time it begins heading until it is fully headed. There is little loss, however, when the grass is allowed to grow until the seed has reached the soft-dough stage, and only one cutting is then required to harvest the crop and obtain a maximum yield of forage.

There are very few hay grasses which are injured so little by standing beyond the proper stage of maturity as Sudan grass. This is due largely to the numerous tillers, which, arising from the base, mature successfully later than the primary stem and provide immature stalks throughout the entire growing season. There is in addition the fact that, like the sorghums, it holds its leaves well and makes the best quality of fodder when the seed has reached the dough stage. This characteristic makes it possible, where necessary, to extend the haying process over a long period without any material loss either in the quantity or quality of the hay. Such a feature is of great importance to the farmer, since haying is often interfered with by other work or by rains which prevent cutting at the most favorable time.

The scarcity of roughage, the presence of a drought, or the danger of loss from insects may also enter into the decision as to when Sudan grass should be harvested. If feed is scarce or the weather turns dry or grasshoppers become destructive, a good crop of hay can be harvested in 50 to 55 days from the date of seeding; and even though the grass has not then reached the proper stage of maturity for cutting, it should under such conditions be harvested.

UTILIZATION.

HAY.

Sudan grass is primarily a hay grass, its slender leafy stems making it easy to handle with the ordinary haying machinery. It yields well in most parts of the United States, and the hay is relished by cattle, horses, and sheep.

The feeding value of Sudan grass hay is practically equal to that of millet, timothy, Johnson grass, and other nonlegume roughages. This fact has been established both by chemical analyses and by practical feeding tests.[4] Work stock can be wintered in good condition on Sudan grass hay without any supplementary grain ration. Farmers report that horses and mules stand plowing and other hard work in the hot summer months better when fed Sudan grass hay than when their roughage is alfalfa.

Stock cattle were maintained economically by the Kansas Agricultural Experiment Station on a ration of Sudan grass hay, sorghum silage, and a small supplementary ration of linseed or cottonseed meal. In another feeding experiment, milk cows produced 97.8 per cent as much milk on Sudan grass hay as on alfalfa hay. Hundreds of farmers testify that cattle, horses, and sheep all eat Sudan grass hay with no derangement of the digestive processes and with good results when measured in gains of flesh, ability to work, or to produce milk. Experts in feeding livestock claim, however, that Sudan grass hay gives the best results only when fed in connection with other forage. It should not be used as the sole roughage in rationing any kind of farm animals.

SOILING AND SILAGE.

Sudan grass is admirably suited for use as a soiling crop, since it makes a large yield and is very palatable in the green state. By this method of feeding, a small area in the South, where the rainfall is adequate or where irrigation is possible, can be made to support a goodly number of animals. Large yields are secured under irrigation, because the growth is so rapid and the recovery from cutting so prompt.

The use of Sudan grass for silage will no doubt be limited, owing to the ease with which it can be made into hay, to the fact that there is but little waste in feeding it as hay, and to the larger silage yields of the sorghums and corn. The Oklahoma experiment station[5] has conducted some experiments with Sudan grass silage. A considerable number of analyses were made which showed that Sudan grass silage was about the same in chemical composition as corn silage. Sheep did not relish the silage as well as they did corn silage, but they liked it equally as well as they did the silage made from grain sorghums.

Mixtures of Sudan grass with cowpeas or soybeans can be grown for silage in humid regions. Such mixtures make a bright-colored, palatable silage of high feeding value.

---

[4] A summary of these analyses and the results of feeding tests will be found in U. S. Dept. Agr. Bul. 981, p. 41–46. Out of print; may be consulted in libraries.

[5] Francis, C. K., and W. G. Friedmann. Okla. Agr. Expt. Sta. Bul. 115, 8 p. 1917.

PASTURE.

Sudan grass has attained popularity as a summer pasture crop. In regions of low rainfall and high temperatures, its carrying capacity during the hot summer months is superior to that of any other grass or legume. On the experimental farm at Dodge City, Kans., a herd of milk cows was pastured alternately on Sudan grass and on

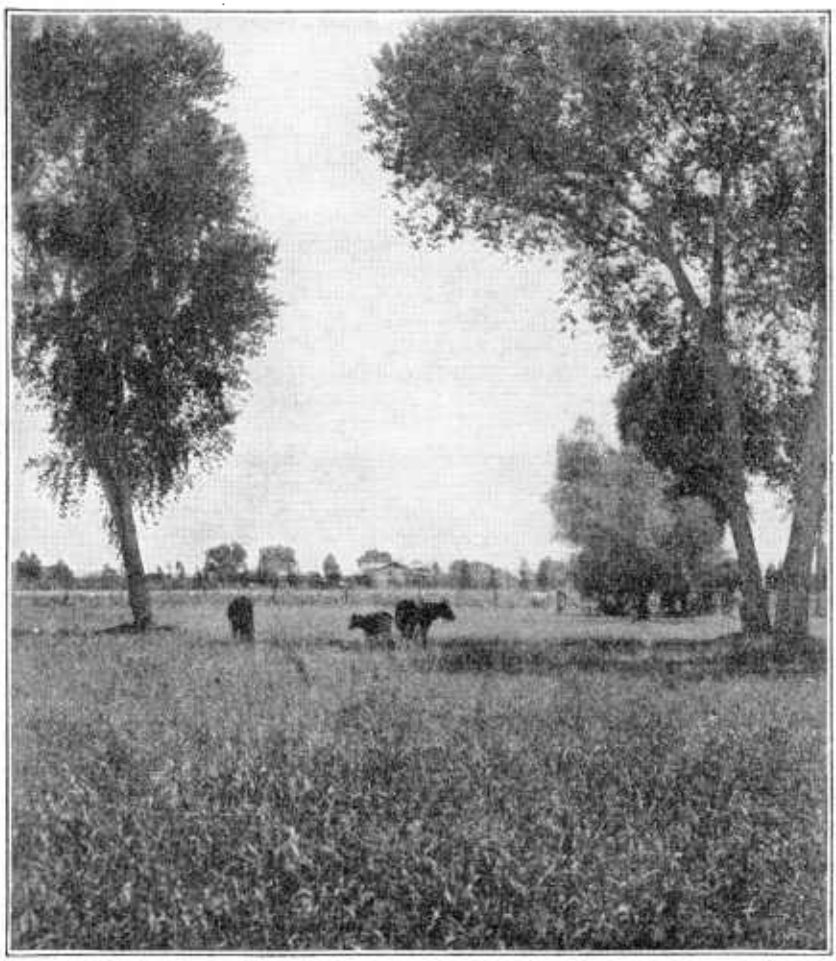


FIG. 9.—Cows pasturing on irrigated Sudan grass at Bard, Calif.

native grasses. The Sudan grass furnished abundant pasturage at the rate of one cow per acre for 125 days, and the cows made a daily average of 3.8 pounds more milk per cow on the Sudan grass than on the native grasses.

At Chillicothe, Tex., mules, horses, and cows allowed the run of a field containing equal areas of Amber sorgo, Golden millet, and Sudan grass all showed a decided preference for the Sudan grass. At the Arizona experiment farm near Prescott, Ariz., Sudan grass

without irrigation maintained 20 sheep per acre continuously for 100 days. The sheep pastured on Sudan grass fattened, while those grazing Amber sorgo made only ordinary growth. The California experiment station pastured a nonirrigated field of Sudan grass with sheep at the rate of 22 head per acre. The sheep made gains of one-third of a pound a day while on the pasture, and no injurious effects were noted.

Sudan grass is also one of the best pasture grasses for irrigated lands in the Southwest. On the Yuma Experiment Farm at Bard, Calif., a small area of about 8 acres was pastured for six months with milk cows and work horses (fig. 9). The field was divided in halves and each half pastured alternately in periods of two to three weeks. The grass was irrigated in each case as soon as the animals were removed. The field maintained an average of three head per acre in good condition throughout the entire period.

In Australia Sudan grass was compared with Dallis grass as a pasture for dairy cows. Although the cows were turned on the Sudan grass later in their lactation period than when pasturing the Dallis grass, the yield of milk was greater from Sudan than from Dallis grass.

At the Kansas Agricultural Experiment Station, Manhattan, Kans.,[6] six Holstein cows were pastured on Sudan grass from July 10 to October 11. They were fed a grain mixture at the rate of 1 pound to each 4 pounds of milk produced. The returns from the pasture, including about 1½ tons of hay per acre which was harvested to keep the grass down, were $47.47 an acre above the value of the grain fed. This result was obtained by reckoning the butterfat at market prices and the skim milk at 50 cents a hundred pounds. Estimated by valuing the whole milk at 30 cents a gallon, the returns amounted to $73.55 per acre above the cost of the grain consumed.

Besides these more or less definite tests by experiment stations, numerous farmers have reported excellent results with Sudan grass pasture. This is particularly true in Indiana, Illinois, Iowa, and eastern Kansas, where it is being utilized as a summer pasture by scores of farmers.

Hogs relish the grass, and when they have access to Sudan grass pasture good gains can be produced with 60 to 70 per cent of the customary grain ration.

Sudan grass, like Johnson grass, is less likely to contain dangerous amounts of prussic acid than the larger sorghums. Where the growth is normal and not checked by drought or frost there is little or no danger of poisoning when the grass is pastured, and none at all from feeding properly cured Sudan hay. However, during years like 1934, when severe droughts occur over almost the entire area in which Sudan grass is grown extensively, the danger of prussic-acid poisoning is magnified many times, and losses due to grazing Sudan grass are frequent. In such years extreme caution in grazing Sudan grass should be observed, especially in the northern Great Plains, where the danger of loss appears greater than it is in the South and East.

[6] Call, L. E., and J. B. Fitch. Sudan grass as a supplementary pasture crop for dairy cattle. Kans. Agr. Exp. Sta. Cir. 80, 4 p. 1920.

Several facts in regard to prussic-acid poisoning should be kept in mind by the grower of Sudan grass.

(1) The formation of prussic acid is most frequent in Sudan grass that has been injured by drought or other unfavorable soil and climatic conditions.

(2) Hogs can be pastured on Sudan grass in safety, and horses and sheep are less susceptible to the poison than cattle.

(3) Sudan grass poisoning is almost unknown in the Southern States and east of the ninety-eighth meridian. North of Oklahoma and west of the ninety-eighth meridian care must be exercised in pasturing Sudan grass with cattle.

(4) A remedy for prussic-acid poisoning has recently been discovered by workers in the Bureau of Animal Industry, United States Department of Agriculture. A mixture of sodium thiosulphate with sodium nitrite, if administered in time, will be found effective. The treatment, which is described in United States Department of Agriculture Leaflet 88 (revised edition), should if possible be given by a skilled veterinarian.

SEED PRODUCTION.

Sudan grass produces seed freely in a loose, open panicle which is held nearly erect by the stem and can be harvested easily. The seed is retained fairly well, and thus the loss from shattering is much less than in other wild forms of sorghum. However, on the Great Plains, high winds sometimes shatter out a large percentage of the seed.

At the present time most of the commercial Sudan grass seed is produced in Texas, Oklahoma, and Kansas, but western Missouri and eastern Colorado and New Mexico also produce more seed than is needed for local consumption. Seed yields per acre are largest in the irrigated regions of California and Arizona, but only limited acreages are devoted to Sudan grass in these localities because of the profitable returns from other crops. The yields of seed per acre obtained in different sections of the United States are shown in Table 2.

TABLE 2.—*Yields of Sudan grass seed under different climatic conditions in cultivated rows and close drills.*

Climatic conditions.	Yield of seed per acre (pounds).			Number of localities.[1]
	Broadcast or close drills	Cultivated rows 18 to 24 inches apart.	Cultivated rows 36 to 44 inches apart.	
Humid	328	417	354	10
Dry (not irrigated)	206	285	271	12
Dry (irrigated)	1,123	966	905	7

[1] The yields for the humid regions are averages for tests at Manhattan, Kans.; Stillwater, Okla.; Beeville and Temple, Tex.; Jackson, Tenn.; St. Paul, Minn.; Madison, Wis.; College Park, Md.; and Arlington Farm and Blacksburg, Va.; for dry regions not irrigated, averages of tests at Colby, Hays, Tribune, Garden City, and Dodge City, Kans.; Chillicothe, Spur, Lubbock, Amarillo, and Dalhart, Tex.; Ritzville and Wenatchee, Wash.; and Davis, Calif.; for dry regions irrigated, averages of tests at San Antonio, Tex., Phoenix, Ariz.; Bard, Davis, and Chico, Calif.; and Umatilla, Oreg.

These yields represent rather accurately the possibilities of seed production in different parts of the United States. Of course, certain localities are better suited to seed production than others. In Lubbock, Crosby, Floyd, Hale, and Swisher Counties in Texas the seed yields average about 600 pounds per acre for Sudan grass planted in rows, as compared with an average for the entire non-irrigated lands in the dry regions of only 270 pounds per acre. After

the market demands for Sudan grass seed become better established, the seed production will no doubt be centered in favored localities, as it now is for such crops as Kentucky bluegrass, timothy, orchard grass, vetch, and alfalfa.

The planting of Sudan grass for seed production has already been described. Harvesting the seed is accomplished most economically with an ordinary grain binder or a row binder. Harvesting with a row binder is illustrated on the title-page. When the seed is practically mature, Sudan grass can be cut and bound like grain and left to cure in shocks. It may then be hauled directly to the threshing machine or stacked in the same manner as bundle grain. There is danger in stacking Sudan grass, however, because the sap in the stems dries out slowly, and if stacked before it has cured thoroughly the grass will heat in the stack and injure the viability of the seed. Growers usually find it best, therefore, to allow the Sudan grass to remain in the shock until they are ready to thresh. The use of shock covers results in a much brighter, better quality of seed.

The ordinary grain separator threshes and cleans Sudan grass seed very satisfactorily. Care must be observed to so regulate the air blast as to prevent seed from being blown over into the straw pile. A clover huller also has been used with success in threshing Sudan grass, but seed threshed in a clover huller is likely to be rather completely freed from the hulls and therefore weighs much heavier than ordinary seed.

The weight of the seed varies from 25 to 40 pounds per bushel. Good clean seed should weigh 36 to 40 pounds to the bushel, and such seed will pass through the feed of an ordinary grain drill without clogging.

In the early years of cultivation in this country, seed sold at retail at $1.50 to $2 a pound, and the farmers realized 50 cents to $1.50 a pound for their seed in bulk. At such prices seed growing was very profitable. Since, however, the price received by the grower has fluctuated from 1½ to 32 cents a pound for seed in bulk, and the retail price for this seed in producing sections has varied from 6 to 40 cents a pound. There is little profit in the production of Sudan grass seed when it nets the grower less than 6 cents a pound. The threshed Sudan grass is said to have about the same feeding value as prairie hay.

The seed of Sudan grass resembles Johnson grass seed very closely, except that it is larger and more plump (fig. 10). No machinery for separating the two kinds of seed has been devised; hence the only way of obtaining pure Sudan grass seed is to guard against its mixture with Johnson grass during the growing period and in the threshing process. South of 38° north latitude, indicated on the map shown as Figure 3, Johnson grass behaves as a perennial and is troublesome because it is difficult to eradicate. North of the thirty-eighth parallel of latitude, roughly speaking, Johnson grass is not troublesome, because it usually is killed by the winter freezes. A slight admixture of Johnson grass in the Sudan grass seed sown for hay production north of the thirty-eighth parallel is no great disadvantage. South of this line, where Johnson grass is likely to become a pest, care must be used to see that the Sudan grass seed is free from Johnson grass seed.

The following suggestions may be remembered with advantage by the farmer in the Southern States: A farmer may grow sufficient seed for his own plantings and thus be assured of its purity; when he finds it nccessary to buy Sudan grass seed and his land is free from Johnson grass, he should purchase only that grown outside the Johnson grass region or from responsible growers in the South who can guarantee the purity of the seed. If the Sudan grass is to be seeded on land already containing Johnson grass, the presence of seed of the latter is a matter of small importance.

The presence of even a small number of Johnson grass seeds can be detected by a properly trained seed analyst. A method for their identification has been formulated by F. H. Hillman, of the United States Department of Agriculture, and is described fully in Department Bulletin 406.[1]

A point to be remembered in the production of Sudan grass seed is that the plant hybridizes very freely with sorghum, especially

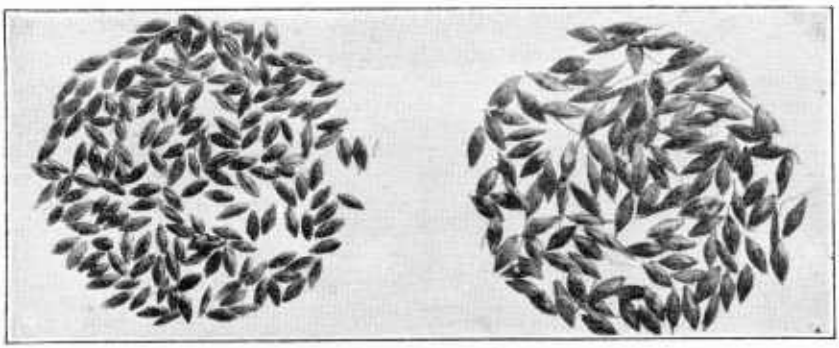


FIG. 10.—Seeds of Johnson grass (left) and Sudan grass (right), showing their comparative size and their similarity in shape.

with the sorgos. In dry regions where the pollen is carried for considerable distances by the wind, a Sudan grass field intended for a seed crop should be 60 to 80 rods from any sorghum. Another source of cross-pollination exists in the volunteer plants of sorghum sometimes found in fields that were planted to sorghum the previous year. To avoid such sources of trouble, fields that have been growing other crops than sorghum should be chosen for the Sudan grass seed crop.

To make sure of pure seed, roguing the field at least once a year must be resorted to, and the rogues should be removed before a chance has been afforded for cross-pollination. The great need of special efforts to keep Sudan grass pure is illustrated by the present condition of the sorgos, very few fields of which are to be found anywhere that are pure as to variety. They are very commonly mixed not only with other varieties of sorgo, but also with the grain sorghums. Unless seedsmen and growers unite in an effort to keep their seed fields free from sorghum hybrids, Sudan grass will lose much of its distinctiveness within the next 20 years.

[1] Out of print, but may be consulted in libraries.

DISEASES OF SUDAN GRASS.[7]

BACTERIAL DISEASES.

Sudan grass is subject to serious attack by at least three bacterial diseases. The bacterial spot disease (*Pseudomonas holci* Kendr.) is characterized by round or elliptical, sometimes irregular, lesions on the leaves which vary from 1 to 8 mm. in diameter. At first the spots are dark green and water-soaked, but they soon become dry and have a tan, parchmentlike center with a red border. Very small lesions are red throughout.

The bacterial streak disease (*Bacterium holcicola* Elliott) is characterized by dark reddish-brown streaks on the leaves. At first the lesions are narrow water-soaked streaks 2 to 3 mm. broad and 2 to 15 cm. or more long. Red-brown blotches of color soon appear in these streaks, and in a few days the entire lesions are reddish brown. When numerous, the lesions coalesce to form long, irregular streaks covering a part or the whole width of the leaf blade and having more or less dead tissue with narrow dark margins between the reddish-brown streaks. Exudate is abundant, standing out on the young lesions as light-yellow beads, which dry to thin white or cream-colored scales.

The bacterial stripe disease (*Bacterium andropogoni* E. F. Smith) is characterized by elongating red streaks and blotches on the leaves with red crusts of dried bacterial exudate on the lower surface. The lesions may be narrow and bounded by veins or may fuse and cover a large part of the leaf surface. The lesions are most abundant on the leaves but may extend to the sheaths and stalks. Their ends may be blunt or extended into long jagged points. The lesions are brick red to dark purplish red throughout, lacking the brown color found in the bacterial streak disease and the oval spots with tan centers and red borders found in the bacterial spot disease.

The bacteria causing these diseases apparently are spread from leaf to leaf by splashing and blowing rain and possibly by air currents and insects. In moist warm weather the bacterial lesions increase rapidly in number and size and under these conditions are capable of killing much of the leaf surface. There is evidence that these parasites may be carried over winter in or on the seed and that they may overwinter also in the soil. No effective control measures for these diseases are known, but crop rotation and selection of seed from fields free from the diseases have been suggested. Inoculation experiments and field observations have shown varietal differences in susceptibility and resistance to bacterial stripe in the case of the grain sorghums. It is possible that strains of Sudan grass resistant to these diseases could be obtained by selection or hybridization, but none are available at this time.

LEAF BLIGHT.

Helminthosporium turcicum Pass, the fungus that causes leaf blight of corn, also attacks Sudan grass and has been reported on the latter host from Texas, North Carolina, Missouri, and Maryland. On

[7] Prepared by H. W. Johnson, pathologist, Division of Forage Crops and Diseases.

Sudan grass the disease is characterized by elongated straw-colored lesions with reddish-brown or brownish margins. As the season progresses, the enlarging lesions coalesce until large portions of the leaves are involved. The tissue in the affected areas is dry, and cracks develop until eventually the leaves may be shredded into ribbons by whipping in the wind. The disease usually becomes evident in late summer or early fall and following a rainy period may appear as a sudden scorch of the leaves, as if the plants had been injured by an early frost. The spore-bearing threads and the dark spores of the fungus often show as a black fuzzy growth on the straw-colored lesions. It has been suggested that late planting and low fertility are contributing factors to outbreaks of the disease in corn. Efforts are being made to obtain strains of Sudan grass resistant to leaf blight by selection and hybridization with sweet sorghums, but such strains are not yet available.

ANTHRACNOSE.

Anthracnose (*Colletotrichum graminicolum* (Ces.) Wilson) of Sudan grass has been reported from the following States: Alabama, Indiana, Mississippi, Missouri, New Jersey, North Carolina, North Dakota, Texas, and Virginia. The disease appears to be especially severe in some years in the Southeastern States and was reported to have caused a partial failure of the Sudan and Johnson grass hay crops in some sections of Alabama in 1917. The disease is characterized by small, reddish-brown, round lesions on the leaves. At first these are only a few millimeters in diameter, but with favorable conditions for disease development the small lesions become confluent, and large areas of the leaves are killed. The minute, spore-bearing bodies of the fungus occur abundantly as tiny dark dots on the mature lesions. No control measures for this disease are known, but it is probable that disease-resistant strains, when available, will offer the best means of control.

LEAF SPOT.

The leaf spot caused by *Ascochyta sorghina* Sacc. has been reported on Sudan grass up to the present from Georgia only. In that State the fungus appears to be a vigorous, well-established parasite capable of causing considerable damage. The disease is characterized at first by small, irregular, brick-red spots on the leaves, which under favorable conditions elongate rapidly and soon coalesce, involving large portions of the leaves. Eventually entire leaves are killed and turn reddish brown in color. At this stage the disease lesions often appear as dark-purple streaks. The tiny black fruiting dots of the fungus are visible in the early stages of the development of the brick-red, elongate spots and after the death of the leaf develop abundantly on the dead brown tissue between the purplish streaks. The same leaf spot has been reported on sorghum in Alabama, and it would appear probable that this disease may likewise be a factor in Sudan grass failure in the southeastern part of the United States in some seasons. As yet no control measures are known.

KERNEL SMUT.

Sudan grass is subject to attack also by *Sphacelotheca sorghi* (Link) Clinton, the cause of the covered kernel smut of sorghums. This

disease of Sudan grass has been reported from Colorado, Iowa, Kansas, Nebraska, North Carolina, Oregon, Texas, and Washington. The fungus has a life history similar to that of covered smut of wheat. Infection occurs only in the seedling stage from smut spores on the seed or perhaps in the soil. The fungus threads then penetrate throughout the growing Sudan grass plant, but the disease does not become evident until heading time, when it will be noticed that individual kernels have become replaced by a dark-brown to black mass of smut spores covered by a grayish membrane. These spore masses look like an elongated seed, fully twice as large as the healthy kernels. Although this disease of the seed is not of any great importance in the production of Sudan grass for hay and pasture, it is a factor that must receive consideration as new, improved strains of this grass are brought into seed production in this country.

Covered kernel smut is easily controlled by the dust seed treatments used for covered smut of wheat. Either copper carbonate dust or ethyl mercuric phosphate dust [8] may be used. Directions for their use may be found in Farmers' Bulletin 1711, Wheat Smuts and Their Control, and in Miscellaneous Publication 219, Treat Seed Grain.

INSECT ENEMIES OF SUDAN GRASS.[9]

GRASSHOPPERS.

In parts of the United States where grasshoppers are abundant they do considerable damage to Sudan grass. These grasshoppers are chiefly native species which hatch out in the vicinity. The cultivation of fields and fence rows late in the fall or in early winter destroys large quantities of the eggs and helps to keep these pests in check. The most effective method of controlling the grasshopper is by poisoned bran mash. This poisoned mash is made up as follows:

Bran	pounds	25
Paris green or white arsenic	do	1
Molasses	quarts	2
Oranges or lemons (finely chopped)	number	6
Water	gallons	3½

The Paris green and bran are thoroughly mixed dry in some receptacle, such as a washtub. The juice of the oranges or lemons is squeezed into the water, the pulp and peeling chopped fine and added, after which some strong-smelling molasses is dissolved in the water, and the poisoned bran is moistened with this solution.

Early in the morning is the best time to scatter this damp mash about fields where the grasshoppers are troublesome. The quantity described in the foregoing formula is sufficient for 4 or 5 acres.

CHINCH BUG.

The chinch bug, though not as frequently troublesome as the grasshopper, does considerable damage when it is abundant. A field of

[8] This dust is marketed under the name of New Improved Ceresan.

[9] This discussion of insects was prepared with the advice and cooperation of W. R. Walton, Office of Cereal and Forage Insect Investigations, Bureau of Entomology and Plant Quarantine, United States Department of Agriculture.

Sudan grass can be protected from a threatened invasion of chinch bugs by means of a deep furrow plowed around the edges of the field, the land side of the plow being toward the field. Holes with perpendicular sides are then dug across the bottom of the ditch at intervals of 30 to 40 feet. The chinch bugs in attempting to cross this furrow collect in the holes and can be destroyed by an application of kerosene oil.

Chinch bugs commonly pass the winter at the base of bunches of grass and in the piles of trash usually found along fences and hedgerows. Burning this grass and trash in November or December destroys a large percentage of the chinch bugs and does much to prevent trouble from them the following summer.[10]

SORGHUM MIDGE.

This insect is destructive only in the South. It very largely prevents the profitable production of Sudan grass seed from central Texas east to the Atlantic coast. The damage to the plant is slight, other than the prevention of seed formation; therefore, there is little loss from a forage standpoint.

There is no effective way of combating the sorghum midge other than planting very early or very late in the season, so that the Sudan grass will come into bloom at a time when the midge is not abundant.

IMPROVEMENT OF SUDAN GRASS.

Because of the value and importance of Sudan grass as a supplementary pasture crop, considerable effort is now being made to improve its forage value by selection and breeding for disease resistance and lower prussic acid content. As a result of the intensive breeding programs carried on by the Bureau of Plant Industry and a number of State agricultural experiment stations, several promising strains have been developed but will not be available for general distribution until they have been thoroughly tested for regional adaptation and performance.

---

[10] Farmers' Bulletin No. 1780, How to Fight the Chinch Bug.

U. S. GOVERNMENT PRINTING OFFICE: 1941

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents